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CONTENTS:

ON A COLLECTION OF FOSSIL VERTEBRATES MADE BY DR. F. W. CRAGIN FROM THE EQUUS BEDS OF KANSAS, . . . *Oliver P. Hay.*

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On a Collection of Fossil Vertebrates Made by Dr. F. W. Cragin in the Equus Beds of Kansas.*

BY OLIVER P. HAY.

IN the sixth volume of the Colorado College Studies, on pages 53 and 54, issued at Colorado Springs, Colo., March, 1896, Dr. F. W. Cragin made a brief report on some vertebrate fossils which he had discovered in 1891, in Meade and Clark counties, Kansas. Later Doctor Cragin became interested in other studies and did not come back to these fossils. These now form a part of the collection of Colorado College, and, through the kindness of the honorary director of the museum, Mr. Edward R. Warren, the writer has been permitted to bring them to Washington and to study them.

A portion of the fossils were found near the head of Bluff creek, in the western part of Clark county, east of Minneola, and the others along Spring creek, a tributary of Crooked creek, about four miles southwest of Meade, in Meade county. In this region Doctor Cragin discovered three terranes, the lowest of which, varying from ten to forty feet in thickness, he named the Meade gravels. He recognized that these gravels belonged to what has been called the Equus beds. From them he reported *Elephas imperator* (?), *Megalonyx leidyi; Equus complicatus, E. curvidens,* and *Auchenia huerfanensis.*

Overlying the Meade gravels there was found a bed of volcanic ash which reached a thickness of thirteen feet. This contained few fossils. It was named the Pearlette. Above this ash bed were found marls, to which was applied the name Kingsdown. In that region the marls were apparently not less than 100 feet thick. Only *Elephas* was reported from them.

All of the materials of the collection made by Cragin which have been studied by the writer belong to the lowest terrane, the

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Meade gravels. The following species have been determined, of which two are new:

Testudo equicomes, new species.
Mylodon harlani Owen.
Hipparion cragini, new species.
Equus complicatus Leidy.
E. leidyi Hay.
Camelops huerfanensis (Cragin).
Canis occidentalis? Richardson.
A large undetermined felid.

Testudo equicomes, new species.

In the Cragin collection made on Spring creek in Meade county there are eight fragments of bones which belonged to species of the genus *Testudo*. It is quite certain that three or four species are indicated, but only two of the fragments can be assigned to the same individual or species. To these the name *Testudo equicomes* is given. The other pieces of bone can not be assigned to their species.

The two bones which quite certainly belonged to the same individual are the right epiplastron and the left hypoplastron. The epiplastron (pl. I, figs. 1, 2) has a projecting and much thickened beak. The distance from the midline in front to the point on the free border where the bone joined the hypoplastron is 68 mm. The width of the bone at the middle of its length is 30 mm. The length of the beak, measured on its upper surface and at the midline, is 35 mm.; and at its rear it is 27 mm. thick. The whole free border of the bone is acute. From this border the hinder half of the bone thickens until, at a short distance behind the beak, it reaches a thickness of 11 mm.

The hinder and inner borders of the hypoplastron (pl. I, fig. 3) are missing, so that the bone present reaches neither the midline nor the hypoplastron. From the anterior end of its free border to the axillary notch is a distance of 30 mm.

Figure 1 of plate III represents an attempt to restore the anterior portion of the plastron from the two fragments described above. The lobe appears to have been relatively short and broad. From one axillary notch to the other was apparently 160 mm. From the middle of the line joining these notches to the front of the beak was 66 mm. The entoplastron appears to have been unusually wide, apparently about 80 mm. How it ended behind is conjectural. From the outer edge of one hypoplastron, at the bridge, to that of the other was about 200 mm. Basing the esti-

mates on this width it is concluded that the carapace had a length of about 340 mm. and a width of 290 mm.

As will be observed on the figures, the gular scutes extended backward on the entoplastron. The humeropectoral sulcus bends backward and again forward as it crosses the hypoplastron. This forward curve makes it probable that the sulcus crossed the hinder end of the entoplastron, but this is not certain. Another sulcus just outside of the axillary notch cut off an axillary scute.

This tortoise is quite distinct from *Gopherus polyphemus*. It is probable that a very large species, *T. crassiscutata*, inhabited Kansas and the region further south during the early Pleistocene, inasmuch as it occurs in Texas; but this was far larger, and the bones described above give no indication of having been those of a young animal.

Mylodon harlani Owen.

In the collection are three teeth of a *Mylodon* which seem to belong to the species named above. Cragin reported these as belonging to *Megalonyx*; but they certainly do not belong to that genus. They were found four miles southwest of Meade, Kan.

These teeth are identified as the left first and third upper teeth and the right first of the lower jaw. They are all damaged somewhat and parts have been lost at some time since exhumation.

The first upper tooth is shown on plate I, figure 4; and a section is shown on the plate (pl. III, fig. 2). The present length of the tooth, measured along the greater curve, is 120 mm. Originally it was somewhat, but not greatly, longer. It will be observed that it curved considerably in passing downward and forward from the bottom of the socket. In section the tooth is broadly oval, with the inner face somewhat flattened. The anteroposterior diameter is 21 mm.; the transverse, 17 mm. It will be seen that this resembles closely the section of the first tooth given by Cope (Proc. Amer. Philos. Soc., vol. XXXIV, p. 459, pl. X, fig.1,*a*) and reproduced by the present writer (Geol. Surv. Iowa, vol. XXIII, p. 134, fig. 33). The grinding surface is concave from front to rear and it slopes somewhat downward from the outer side.

The third upper tooth is here shown in section (pl. III, fig. 3). The present height of the tooth is 70 mm., but it was originally higher. The greatest diameter is 36 mm., the width across the anterior lobe, 27 mm. The hinder lobe is 13 mm. thick. The grinding surface shows two planes of wear, one on the broad an-

terior lobe, the other on the hinder lobe. The two meet at the place of union of the two lobes, making an angle of about 135°. This tooth appears to resemble closely the third upper tooth of G. M. Allen's *Mylodon garmani* (Mem. Mus. Comp. Zool., vol. XL, pl. 2, fig. 3) rather more than that represented by Cope (op. cit.); but the latter tooth was not complete, and was pretty certainly incorrectly restored.

The first lower tooth is here shown from behind (pl. I, fig. 5) to illustrate its curvature, and in section (pl. III, fig. 4). The height in a straight line is 90 mm. The anteroposterior diameter is 23 mm.; the transverse 16 mm. The groove along the inner face is deeper than in the section given by Cope. Of this tooth in *Mylodon garmani*, Allen says that the inner side is nearly flat. As in the tooth just referred to, there are two planes of wear, an anterior and a posterior.

Hipparion cragini, new species.

In the collection made by Doctor Cragin there is an upper molar or premolar which seems to belong to a hitherto undescribed species. Accompanying the specimen is a note made by Doctor Cragin which reads as follows:

"Upper part of Bluff Cr., Clark Co., east of Minneola (Thomas ranch), in Pleistocene deposits bearing *Elephas columbi* and *Equus curvidens*. Can this have been derived from the Loup Fork? Latter occurs, but further east."

It is, of course, possible that the tooth was originally left in deposits preceding the Pleistocene. However, it presents no signs of being water-worn, rolled or weathered. It is stained just as are teeth of *Equus* from the same beds.

It is not yet certain that species of *Hipparion* continued on into the Pleistocene; but there are some indications that they did. A tooth of *Hipparion*, referred by the writer with doubt to *Neohipparion gratum* (Geol. Surv. Iowa, vol. XXIII, pl. IX, figs. 1, 2), was found in what is supposed to be Aftonian gravels, at Rockport, Mo. Other remains were discovered in Aftonian gravels near Thayer, Iowa. The occurrence of the tooth here described in Pleistocene deposits in Kansas supports the view that the genus did not become extinct at the close of the Tertiary.

The crown (pl. I, figs. 6, 7) has now a height of 38 mm. on the outer face. The length of the grinding surface is 17 mm.; the width, 17 mm. The protocone has a fore-and-aft diameter of 6.5 mm. At a distance of 25 mm. above the grinding surface the fore-

and-aft diameter of the crown is 16 mm.; the side-to-side diameter, 17.5.

The outer styles are strongly developed, standing out boldly from the face of the tooth. Near the grinding surface these styles have a diameter of 2.5 mm., but toward the root the median widens to 4 mm. The anterior one also widens slightly.

The lakes have the enamel surrounding them only moderately complicated. In the anterior lake there is a deep infold at the hinder inner angle, and a smaller one in the hinder border. In the hinder lake there are a shallow fold and another rather deep one in the anterior border and a moderate one in the hinder border.

The oval protocone is detached from the other columns of the tooth, but lies close to them. A small loop at the head of the hinder inner valley comes nearly into contact with the enamel of the protocone. The inner face of the protocone is very slightly convex.

It is possible that the *Hipparion* teeth mentioned above as being found in the Pleistocene of Missouri and Iowa belong to this species; but while the crown of the Kansas specimen is very straight, that of the Missouri tooth is considerably curved. The protocone of the latter is considerably smaller than is the former.

This tooth differs from those of *H. gratum*, figured by Cope (Proc. Philos. Soc., vol. XXVI, figs. 16, 17) in being much straighter. From these and most of those figured by Leidy (Jour. Phila. Acad., vol. VII, 1869, pl. XVIII, figs. 25-30) the Kansas tooth differs in having the enamel somewhat more simple in its arrangement.

Equus complicatus Leidy.

In the Cragin collection there are a few teeth which are here referred to this species. Of these there are one upper right premolar and five lower cheek teeth. They were found on Spring creek, near Meade. The upper premolar, the third or the fourth, has a height of 80 mm., a length of 33 mm., and a width of 32 mm. The protocone is 17 mm. wide. There is a deep reëntrant loop at the head of the postprotoconal valley, and the enamel of the lakes is considerably complicated.

Three of the lower teeth appear to have belonged to the same animal. These are the two hinder premolars and the first molar (pl. II, fig. 1). The following are the measurements:

Measurements of lower teeth in millimeters.

Tooth.	Height.	Length.	Width.
Pm_3	58	30	17
Pm_4	65	29	17
M_1	56	25.5	15

The enamel of these lower teeth shows little plication of the enamel, and in that respect they are different from those which are in this paper identified as *Equus leidyi*. These teeth are somewhat smaller than might be expected; however, they are all, and especially the molar, worn down to where the length is somewhat diminished.

Equus leidyi Hay.

In the collection there is a part of the left maxilla, which contains the last premolar and all the molars (pl. II, fig. 2). The specimen was found in the Meade gravels, at the head of Bluff creek, in Clark county. It was regarded by Doctor Cragin as *Equus curvidens* Owen; but the teeth of that South American species have the enamel less complicated and the styles stand out less prominently from the outer face.

The teeth of the Bluff creek specimen are those of a horse probably hardly four years old. The last premolar had been but slightly abraded; the hindermost molar had not yet been cut. The first and second molars are only moderately worn.

The maxilla reaches the midline, thus presenting one-half of the width of the palate, which had, between the first molars, a width of 75 mm. The posterior palatine foramen opened opposite the front half of the second molar. The maxillary ridge continued forward to the middle of the last premolar.

The last premolar is slightly curved; the molars are much curved. As one follows them upward from the grinding surface they bend both backward and inward (pl. II, figs. 3, 4). The following measurements are afforded. The length and the width are taken somewhat above the grinding surface. The dimensions of the last molar are of less importance than those of the other teeth.

Measurements of the cheek-teeth in millimeters.

Tooth.	Height.	Length.	Width.	Protocone.
Pm^3	92	28	29	12
M^1	90	27	27	12
M^2	97	27	26	12
M^3	70	26	24	.....

The styles stand out prominently on the outer faces of the teeth. As usual, the anterior one of the premolar is broader than in the molars, but there is no defined groove running along it. The protocone is slightly concave on its inner face. The enamel of the worn teeth, especially that of the first molar, is considerably complicated. There is a notch in the front wall of the anterior lake, while in the hinder wall of the posterior lake there is a deep infold and two or three shallow ones. The adjacent borders of the two lakes have each a very deep infold and two or three shallower ones. In the head of the postprotoconal valley there is a rather deep reëntrant loop.

Besides the tooth described above there are seven loose upper premolars and molars, which were found along Spring creek, four miles southwest of Meade, Kan. I am not sure that the position of certain of the teeth has been correctly determined. In some cases, as Nos. 2 and 6 of the list below, the anterior style is narrow, indicating that the tooth is a molar, but it is traversed from end to end by a shallow groove. In another case, No. 1, the style is broad and without groove. The following are the measurements. It is to be understood that here, as in all other cases, the height of the tooth is given merely to show the amount of wear it has suffered.

Measurements of teeth in millimeters.

Tooth.	Position.	Height.	Length.	Width.	Protocone.
1	Pm^4	80	26	27	12
2	$Pm^{4?}$	90	24	22	13.5
3	$M^{1?}$	60	23	24	15
4	$M^{1 \text{ or } 2}$	75	24	26	12
5	$M^{1 \text{ or } 2}$	65	26	24	15
6	$M^{1?}$	85	24	24	..
7	Pm^4	62	27	27	12
8	Pm^4	58	28	28	12

In the true molars of *E. leidyi* there appears to be a strong tendency to retain the reëntrant loop at the head of the postprotoconal valley.

Among the lower teeth of horses collected on Spring creek are three premolars (pl. III, fig. 5) which appear to have belonged in the left side of the same jaw; and three molars (pl. III, fig. 6) which apparently belonged in the right side of the jaw of the same individual as that which possessed the premolars, or of another individual of the same age. The horses, if more than one, were young, as will be seen from the height of the various teeth.

Measurements of lower teeth in millimeters.

Tooth.	Height.	Length.	Width.
Pm_2	65	28	13
Pm_3	85	28.5	16.5
Pm_4	88	27	15
M_1	78	25	13
M_2	..	29	15
M_3	60	30	12.5

The premolars are curved so as to be slightly convex on the outer face; the first molar is somewhat convex on the inner face and quite strongly convex on the front border. As will be seen from figure 5, the enamel of the premolars is much crinkled; that of the molars somewhat less so. Attention is called to the fact that the length of the grinding face of premolar 2 is not greater than of the next one.

Both in complication of the enamel and in length and width of the grinding surface these teeth resemble closely the teeth from the region about Charleston, S. C., which have been referred to *E. leidyi*.

In size the upper teeth above described agree closely with those forming the type of *Equus excelsus* Leidy. On close comparison it is seen that the styles on the outer face of the teeth of *E. excelsus* stand out more boldly and the intervening channels are deeper and more concave. The enamel of the lakes is far less complicated than in the teeth of the specimens collected by Cragin. That this condition is not due to the greater degree of attrition of the former is shown by the fact that some of the teeth of the Cragin collection are still more worn than those of the type of *E. excelsus*, and they still preserve the deep notches and plication of the enamel. In the type of *E. excelsus* the protocone is much longer than in most of the teeth referred to *E. leidyi*. While not too much importance can be attached to this fact, it must be considered. It seems to the writer that the Kansas specimens certainly do not belong to *Equus excelsus*.

Besides the equine materials above described, Doctor Cragin found on Spring creek a median metacarpal. This bone has a length of 225 mm. along the outer border. The width at the upper end is 46 mm.; at the middle of the length, 32 mm.; across the lower articular surface, 39 mm. The bone is very hard and heavy. It has been, at some stage in its history, much weathered, and it is cracked longitudinally. From the same place is another metacarpal nearly identical in dimensions but differently fossilized. Its length along the outer border is 216 mm.; width at the upper end, 46 mm.; at the middle of the length, 31 mm.; across

the lower articular surface, 41.5 mm. A third metacarpal from the same place is larger. The length is 232 mm.; width at the upper end 51.5 mm.; at the middle of the length, 33 mm.; across the lower articular surface 45 mm.

It seems that two species are indicated here; the latter bone being possibly that of *Equus complicatus*, the other two those of *E. leidyi*.

Besides these there are some phalanges, but none that bore hoofs. There are also two astragali. At least two species of horses are indicated in the phalanges and the astragali.

There are in the collection also four moderately worn incisors.

Camelops huerfanensis (Cragin).

Among the fossils collected on Spring creek are several teeth which the writer can not distinguish from those of the type of Cragin's *Camelops huerfanensis*, and it was to this species that Cragin himself referred them. These teeth consist of nine incisors, four canines, three upper second molars, three lower second molars, two lower third molars, two upper milk-molars, and three lower third milk-molars.

The incisors do not differ from those of specimens found at Minidoka, Idaho (Proc. U. S. Nat. Mus., vol. 46, p. 273, pl. 26, fig. 2). A mature canine, probably of the upper jaw, has the crown bent at right angles with the root and furnished with sharp front and rear edges, as in the lama. Another and stouter canine is somewhat less abruptly bent.

The least worn second upper molar has a height of 75 mm., a length of 50 mm. on the outer face at the grinding surface, and a length of 45 mm. at a point two-thirds the distance to the root. At the base the width of the anterior lobe is 28 mm., of the posterior 26 mm.

A right second lower molar, slightly worn, has a height of 70 mm. (pl. II, fig. 5). Its length at the grinding surface is 47 mm.; at two-thirds the way to the root, 40 mm. The width at the base is 19 mm. There is a well-defined style on the front of the inner face and another on its rear. The two lower last molars furnish the following measurements:

Measurements of hindermost lower molars in millimeters.

	No. 1.	No. 2.
Height	70	70
Length near grinding surface	56	62
Length near the root	60	67
Width of front lobe near base	20	23

No. 2 of the preceding table has a quite thick deposit of cement; that of No. 1 has been dissolved off. A second molar (M_2), which belongs with No. 2, has also a deposit of cement.

The two upper milk-molars are each worn only slightly on its front lobe. One (pl. I, fig. 8) has the anterior face broken off, but it was evidently somewhat smaller than the other tooth. Both have prominent external styles, front, median and posterior. The edges of the anterior and median are directed pretty strongly forward. The middle of the outer face of each lobe forms a prominent rounded ridge.

Measurements of upper milk-molars in millimeters.

Tooth.	Height.	Length of summit.	Length near root.	Width at base.
1	43	45±	32	23
2	45'	48	32	23

Of the three lower third milk-molars, two belong to the left side, one to the right. One of those of the left side is in a fragment of the jaw (pl. II, fig. 6), and it seems to have belonged to the same individual as the tooth of the right side. Each has a little accessory column, 15 mm. high, just behind the median style of the inner face. This column is absent on the other tooth of the left side. The height of the milk-molar figured is 43 mm.; the length at the summit, 54 mm.; near the base, 40 mm.; width at the base, 16 mm.

On Spring creek there were obtained two upper phalanges of camels. They pertained probably to the front limbs. The following measurements are given to aid in making comparisons with other like materials.

Measurements of phalanges in millimeters.

	No. 1.	No. 2.
Length along outer border	130	115
Width across the upper articulatory surface	49	....
Fore-and-aft diameter at middle of length	29.5	24.5
Side-to-side diameter at middle of length	23	21
Width across lower articular surface	38	32

Canis occidentalis ? Richardson.

In the collection is an injured lower right first molar of a wolf which was found on Spring creek, near Meade. This tooth is referred with some doubt to the species above mentioned. Unfortunately, the outer face of the principal cone and that of the anterior cone have been split off and lost; also the front border of the anterior cone is missing. Comparison of the tooth has been

made with the corresponding one of *Canis dirus*, from Rancho La Brea, California; of *C. occidentalis*, from Alaska; and of *C. gigas*, from Oregon. The following measurements have been taken:

Measurements in millimeters.

	Length of tooth.	Width of talon to length of tooth.	Width of principal cone to length of tooth.
Kansas specimen	32.3	37.1:100	38.7:100
La Brea specimen	36.5	35.6:100	43.8:100
Alaska specimen	32.0	35.3:100	40.6:100
Oregon specimen	28.0	32.1:100	44.6:100

It will be observed that, as regards size, the Kansas tooth is much nearer to that of *C. occidentalis* than to any of the others. The tooth differs from all of the other teeth in the width of the talon. The metaconid is somewhat more strongly developed than in *C. occidentalis*. It is possible that this tooth represents a distinct species, but the evidence is not sufficient to establish this.

Undetermined Felid.

In the collection made on Spring creek, about four miles southwest of Meade Center, Kan., are found some remains of a very large cat-like animal. These consist of the left second metacarpal; the proximal three-fourths of the right fifth metacarpal; the right calcaneum; the proximal two-thirds of the right fourth metatarsal; a proximal phalange of probably the fourth digit of the pes; and the distal half of another proximal pedal phalange. There is no certain evidence that any two of the bones were found together, but it seems probable that all belonged to one individual. They shall here be so considered. All these parts indicate an animal somewhat larger than the African lion.

The second metacarpal, as the other bones, is compared with that of a lioness captured in Africa by the Roosevelt party.

Measurements of second metacarpals in millimeters.

Dimensions Taken.	Fossil felid.	*Felis leo.*	Ratio of fossil to *Felis leo* taken as 100.
Total length of bone in straight line	111	94	118
Height of proximal end	32.5	25	130
Width of proximal end	21	19	110
Side-to-side diameter at middle of length	16	12	133
Vertical diameter at middle of length	16	13.5	118
Side-to-side diameter above lower articular surface	23	19	121

The distal end of the fifth metacarpal is broken off, as well as a part of the proximal articulation. The total length of the fragment is 82 mm. The greatest width of the proximal end is 27 mm.; of that of the lioness, 22 mm.

The calcaneum is slightly injured at both ends. The following are the measurements of this calcaneum and that of the lioness:

Measurements of calcanea in millimeters.

Dimensions Taken.	Fossil felid.	*Felis leo.*	Ratio of fossil to *Felis leo* taken as 100.
Total length of bone on outer face	123	90	137
Height of surface for cuboid	31	22	141
Greatest height at surface for astragalus	50	39	128

The calcaneum of another lion is 106 mm. long.

The fourth metatarsal lacks the distal end. The greatest depth of the proximal end is 25 mm.; of that of the lioness, 21.5 mm.

The complete first phalange mentioned is 52 mm. long, measured on the upper surface and at the middle of the width. That of the third digit of the hind foot of the lioness is 41 mm. That of the fossil has the lower face flat or concave from side to side; in the lioness this face is convex from side to side.

DESCRIPTION OF PLATES.

PLATE I.

Figs. 1-3. *Testudo equicomes.* Parts of plastron. Type. × 1. *1*, Right epiplastron, seen from below. *2*, Right epiplastron, showing median suture. *3*, Left hyoplastron, seen from below.

Figs. 4, 5. *Mylodon harlani.* Teeth. × 2-3. *4*, Left front upper tooth, seen from right, or inner, side. *5*, Right first lower tooth, seen from behind.

Figs. 6, 7. *Hipparion cragini.* Two views of a tooth of the right side. Type. × 1. *6*, Tooth seen from right, or outer, side. *7*, View of the grinding surface.

Fig. 8. *Camelops huerfanensis.* Upper left milk-molar, seen from left, or outer, side. × 2-3.

PLATE II.

Fig. 1. *Equus complicatus.* Lower left cheek-teeth, pm_3, pm_4 and m_1.

Figs. 2-4. *Equus leidyi.* Upper jaw and teeth. × 2-3. *2*, Left jaw and four teeth, seen from below. *3*, First molar, seen from left, or outer, side. *4*, First molar, seen from in front.

Figs. 5, 6. *Camelops huerfanensis.* Teeth. × 2-3. *5*, Lower right second molar, seen from right, or outer, side. *6*, Lower right second milk-molar, seen from left, or inner, side.

PLATE III.

FIG. 1. *Testudo equicomes.* Plan of front of plastron of type. × 1-3.

FIGS. 2-4. *Mylodon harlani.* Sections of teeth. × 1. *2*, Section of first upper tooth. *3*, Section of third upper tooth. *4*, Section of first lower tooth. In the case of figures 2 and 4 the fronts of the teeth are above. In figs. 2 and 4 the inner faces of the teeth are toward the left; in figure 3 it is toward the right.

FIGS. 5, 6. *Equus leidyi.* Grinding surface of lower premolars and molars, × 1. *5*, Left premolars. *6*, Right molars.

PLATE I.

PLATE II.

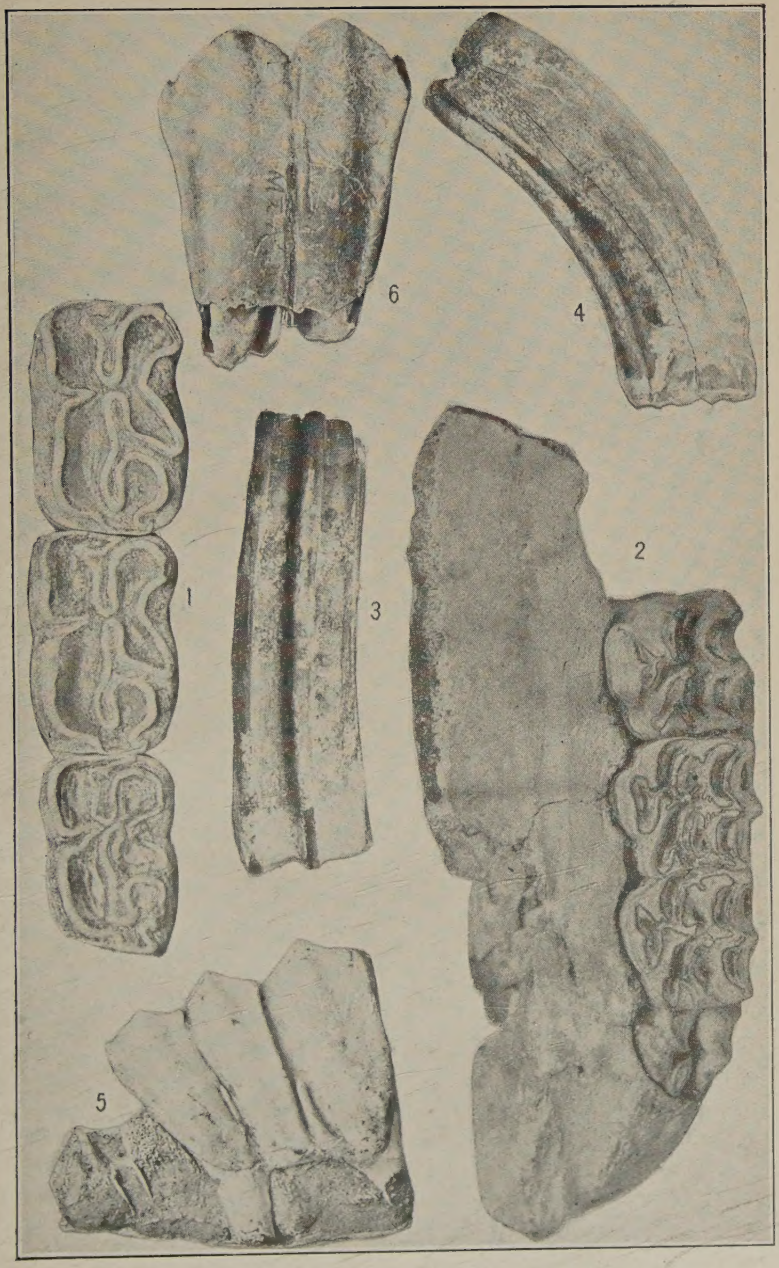
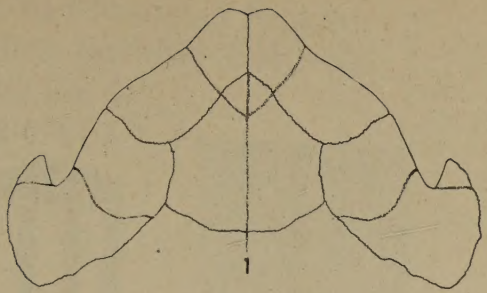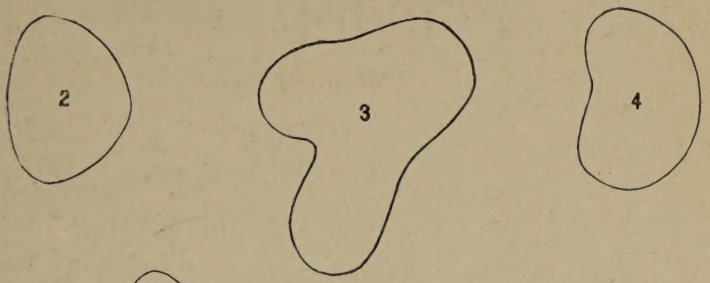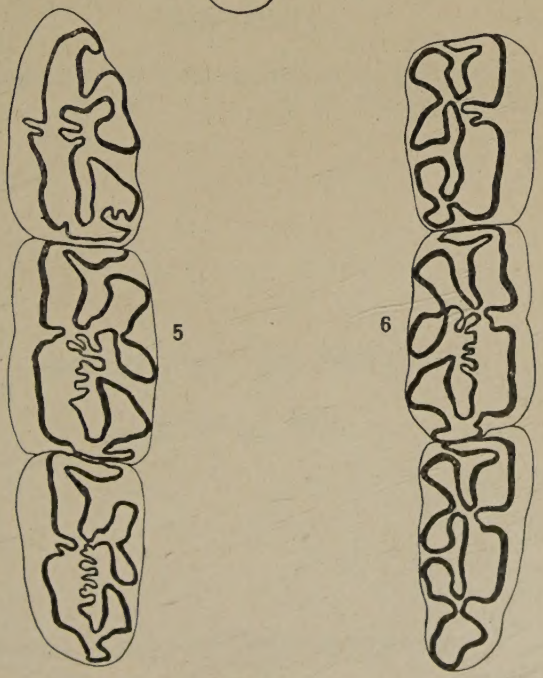
PLATE III.